

TECHNICAL MEMORANDUM

TO: Carl Bach and Dan McCormack, The Boeing Company

FROM: Kris Hendrickson and Mario Lopez

DATE: February 16, 2007

RE: **NBF – SOIL EVALUATION IN AREA OF STORM DRAIN LINE REROUTE**
















This document presents the results from the soil investigation at the North Boeing Field site along the proposed storm drain reroute between building 3-332 and the Seattle City Light Georgetown Steam Plant property. The purpose of this investigation was to document soil conditions along the proposed reroute area between MH187 and MH181A (see Figure 1).

This soil investigation consisted of five exploration borings located along the planned storm drain reroute. Six boring locations were proposed in the work plan, but SLR-6 was not drilled because the drilling rig could not access the planned location. On November 22, 2006, Cascade Drilling was onsite to do the boring investigation with the supervision of Nathan Moxley of Landau Associates and Jennifer Parsons of Boeing. At each location, the driller hand-augered to at least 3 ft below ground surface (BGS) to allow discovery of unknown utilities not identified by the private locator. Boring logs can be seen on Figures 2 through 7.

At each boring location, soil samples were collected at three different 1-ft intervals (1 to 2, 3 to 4, and 5 to 6). In two of the borings (SLR-2 and SLR-3), the driller encountered obstructions and the boring locations were moved north or south of the proposed locations. Samples from SLR-3 were collected from two different boring locations (see Figure 1). All samples were field-screened visually for the presence of petroleum hydrocarbons and volatile organic compounds (VOCs). Based on field screening results, one sample was selected for VOC analysis using U.S. Environmental Protection Agency (EPA) Method 8260, four samples were selected for TCLP metals analysis using the EPA Toxicity Characteristic Leaching Procedure, and three samples were selected for diesel-range and oil-range petroleum hydrocarbons analysis using the Washington State Department of Ecology (Ecology) Method NWTPH-Dx. All soil samples were analyzed for polychlorinated biphenyls (PCBs) using EPA Method 8082. Upon completion of the boring investigation, each boring was abandoned by filling the borehole with bentonite chips and covering the upper 6 inches with cold-patch concrete. Soil cuttings were contained in a drum, labeled, and stored in a secured area.

PCBs were detected in all samples; the highest concentrations were found at SLR-2 and SLR-3. Barium was the only TCLP metal detected; all results were less than the dangerous waste criteria. Diesel-range and/or oil-range petroleum hydrocarbons were detected in each sample analyzed. Several VOCs were detected in the sample analyzed. Table 1 presents the soil analytical results.

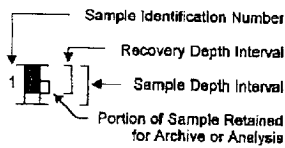
Soil Classification System

MAJOR DIVISIONS		USCS GRAPHIC LETTER SYMBOL SYMBOL ⁽¹⁾		TYPICAL DESCRIPTIONS ⁽²⁾⁽³⁾
COARSE-GRAINED SOIL (More than 50% of material is larger than No. 200 sieve size)	GRAVEL AND GRAVELLY SOIL (More than 50% of coarse fraction retained on No. 4 sieve)	CLEAN GRAVEL (Little or no fines)	 GW	Well-graded gravel; gravel/sand mixture(s); little or no fines
			 GP	Poorly graded gravel; gravel/sand mixture(s); little or no fines
	SAND AND SANDY SOIL (More than 50% of coarse fraction passed through No. 4 sieve)	GRAVEL WITH FINES (Appreciable amount of fines)	 GM	Silty gravel; gravel/sand/silt mixture(s)
			 GC	Clayey gravel; gravel/sand/clay mixture(s)
FINE-GRAINED SOIL (More than 50% of material is smaller than No. 200 sieve size)	SILT AND CLAY (Liquid limit less than 50)	CLEAN SAND (Little or no fines)	 SW	Well-graded sand; gravelly sand; little or no fines
			 SP	Poorly graded sand; gravelly sand; little or no fines
		SAND WITH FINES (Appreciable amount of fines)	 SM	Silty sand; sand/silt mixture(s)
			 SC	Clayey sand; sand/clay mixture(s)
	SILT AND CLAY (Liquid limit greater than 50)		 ML	Inorganic silt and very fine sand; rock flour; silty or clayey fine sand or clayey silt with slight plasticity
			 CL	Inorganic clay of low to medium plasticity; gravelly clay; sandy clay; silty clay; lean clay
			 OL	Organic silt; organic, silty clay of low plasticity
			 MH	Inorganic silt; micaceous or diatomaceous fine sand
HIGHLY ORGANIC SOIL		 CH	Inorganic clay of high plasticity; fat clay	
		 OH	Organic clay of medium to high plasticity; organic silt	
		 PT	Peat; humus; swamp soil with high organic content	

OTHER MATERIALS		GRAPHIC SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS
PAVEMENT			AC or PC	Asphalt concrete pavement or Portland cement pavement
ROCK			RK	Rock (See Rock Classification)
WOOD			WD	Wood, lumber, wood chips
DEBRIS			DB	Construction debris, garbage

- Notes: 1. USCS letter symbols correspond to symbols used by the Unified Soil Classification System and ASTM classification methods. Dual letter symbols (e.g., SP-SM for sand or gravel) indicate soil with an estimated 5-15% fines. Multiple letter symbols (e.g., MU/CL) indicate borderline or multiple soil classifications.
2. Soil descriptions are based on the general approach presented in the *Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)*, outlined in ASTM D 2488. Where laboratory index testing has been conducted, soil classifications are based on the *Standard Test Method for Classification of Soils for Engineering Purposes*, as outlined in ASTM D 2487.
3. Soil description terminology is based on visual estimates (in the absence of laboratory test data) of the percentages of each soil type and is defined as follows:
- Primary Constituent: > 50% - "GRAVEL," "SAND," "SILT," "CLAY," etc.
 - Secondary Constituents: > 30% and ≤ 50% - "very gravelly," "very sandy," "very silty," etc.
 - > 15% and ≤ 30% - "gravelly," "sandy," "silty," etc.
 - Additional Constituents: > 5% and ≤ 15% - "with gravel," "with sand," "with silt," etc.
 - ≤ 5% - "trace gravel," "trace sand," "trace silt," etc., or not noted.

Drilling and Sampling Key		Field and Lab Test Data	
SAMPLER TYPE	SAMPLE NUMBER & INTERVAL		
Code	Description	Code	Description
a	3.25-inch O.D., 2.42-inch I.D. Split Spoon	PP = 1.0	Pocket Penetrometer, tsf
b	2.00-inch O.D., 1.50-inch I.D. Split Spoon	TV = 0.5	Torvane, tsf
c	Shelby Tube	PID = 100	Photoionization Detector VOC screening, ppm
d	Grab Sample	W = 10	Moisture Content, %
e	Single-Tube Core Barrel	D = 120	Dry Density, pcf
f	Double-Tube Core Barrel	-200 = 60	Material smaller than No. 200 sieve, %
g	Other - See text if applicable	GS	Grain Size - See separate figure for data
1	300-lb Hammer, 30-inch Drop	AL	Atterberg Limits - See separate figure for data
2	140-lb Hammer, 30-inch Drop	GT	Other Geotechnical Testing
3	Pushed	CA	Chemical Analysis
4	Rotosonic		
5	Air Rotary (Rock)		
6	Wash Rotary (Rock)		
7	Other - See text if applicable		



Groundwater

Approximate water elevation at time of drilling (ATD) or on date noted. Groundwater levels can fluctuate due to precipitation, seasonal conditions, and other factors.

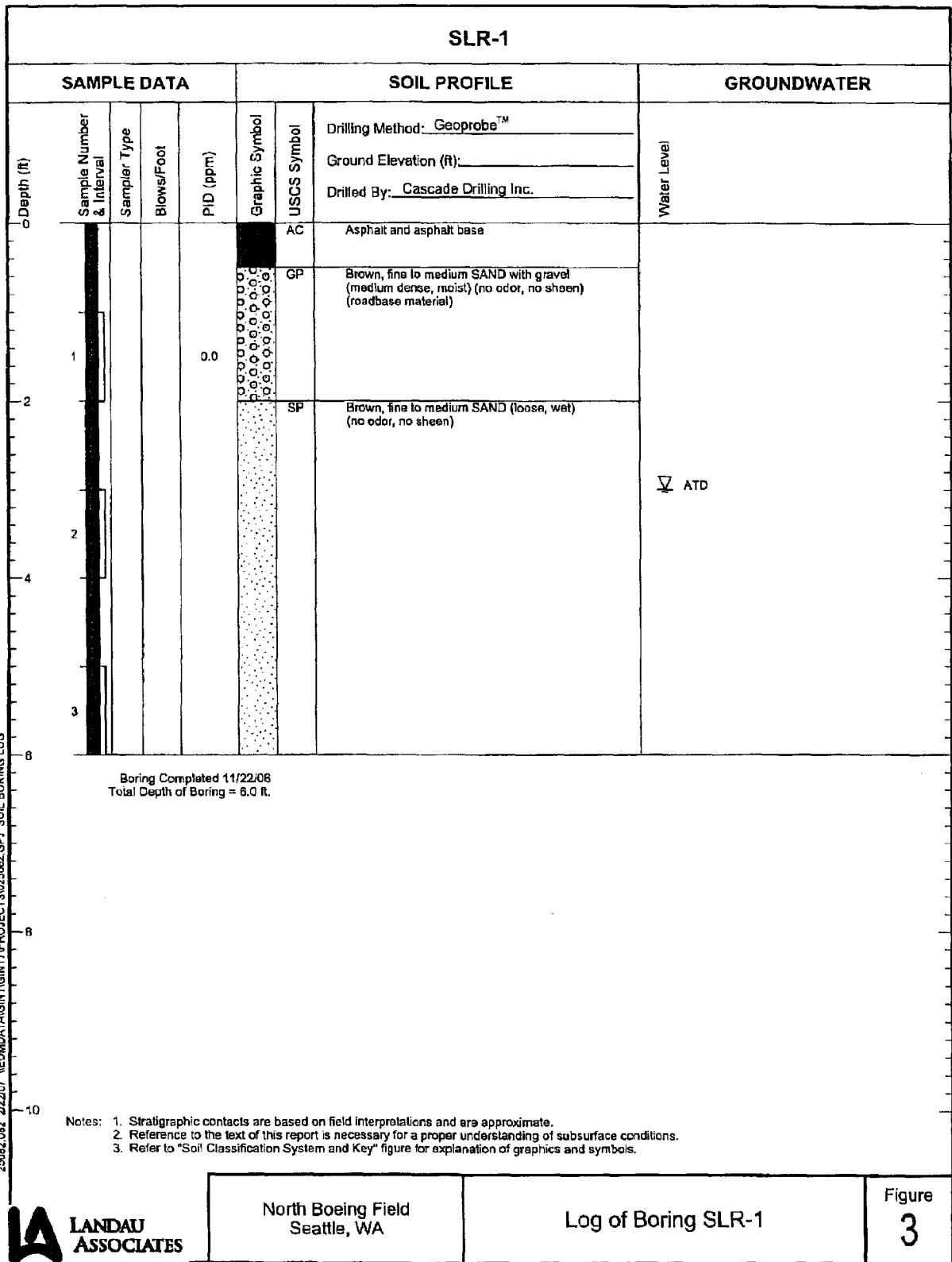
271407 IEDMATAIGINT76PROJECTS025082.GPJ SOIL CLASS SHEET

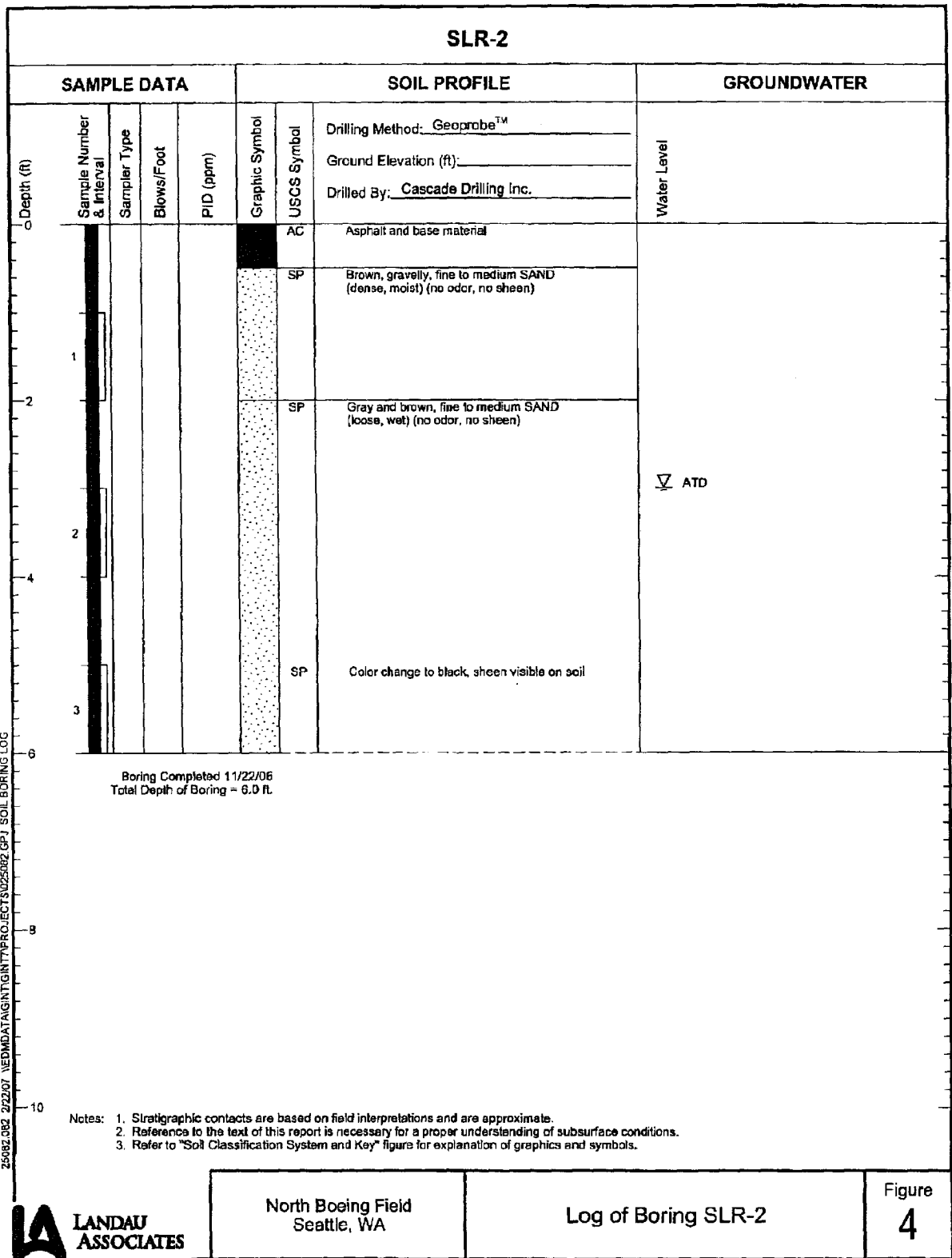


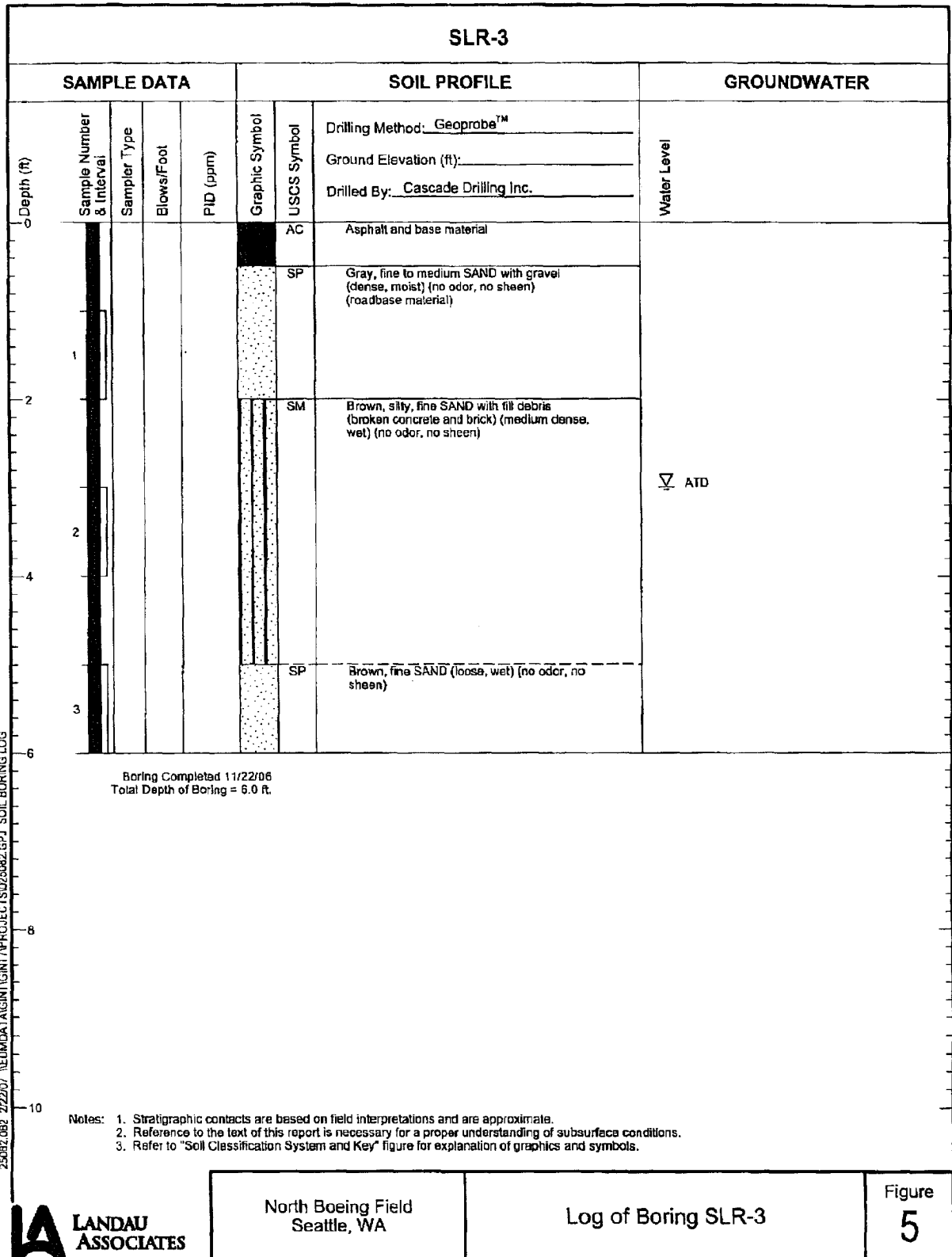
North Boeing Field
Seattle, WA

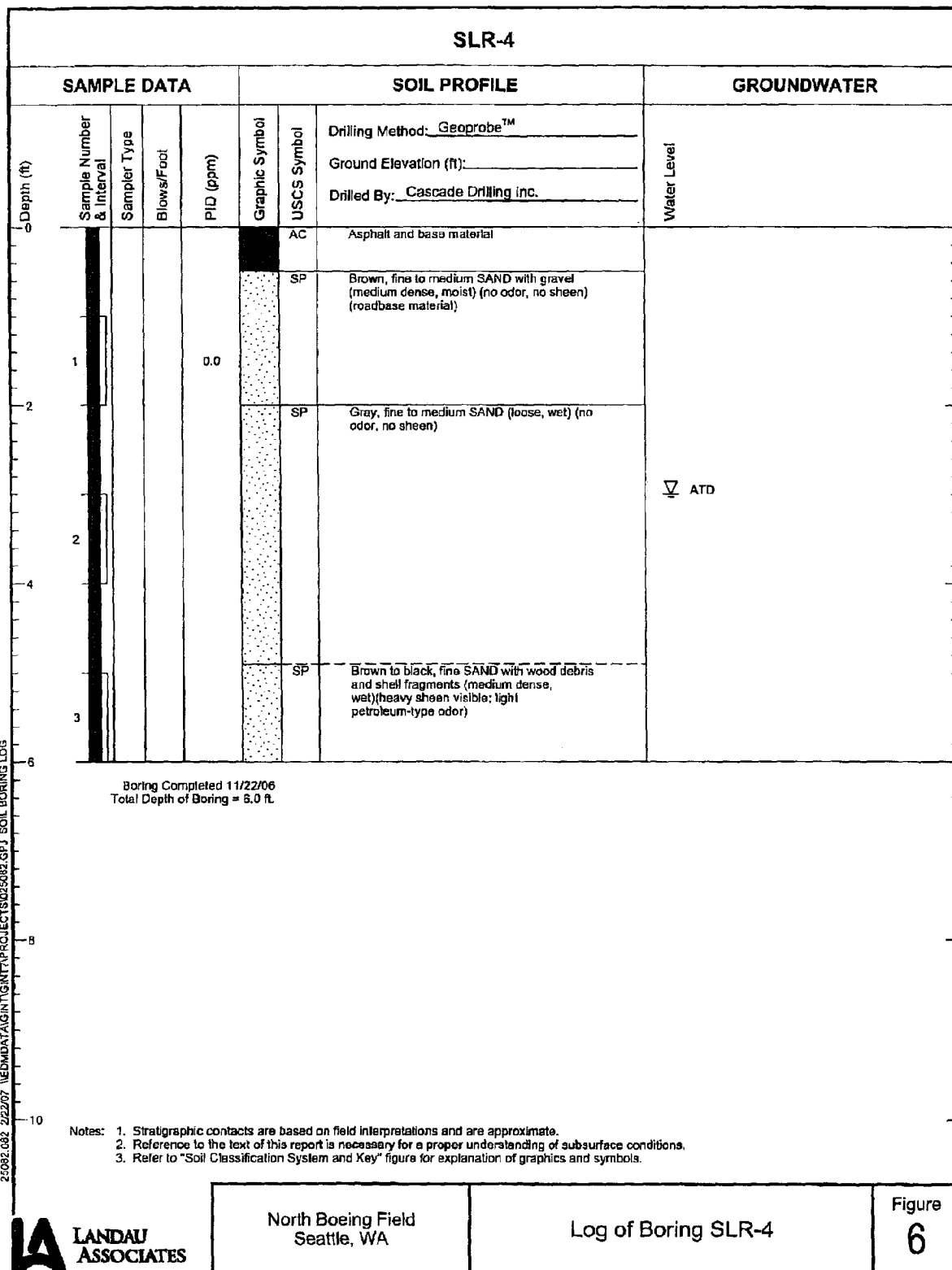
Soil Classification System and Key

Figure
2









SLR-5						
SAMPLE DATA				SOIL PROFILE		GROUNDWATER
Depth (ft)	Sample Number & Interval	Sampler Type	Blows/Foot	PID (ppm)	Graphic Symbol	USCS Symbol
0						AC
					Drilling Method: <u>Geoprobe™</u>	
					Ground Elevation (ft): _____	
					Drilled By: <u>Cascade Drilling Inc.</u>	
					Water Level	
1				0.0		GP/SP
					Asphalt and base material	
2						SP
					Brown and gray, fine to medium SAND with gravel to a gravelly fine to medium Sand (dense, wet) (no odor, no sheen)	
3				0.0		SP
					Gray, fine to medium SAND (loose, wet) (no odor, no sheen)	
4						SP
					Black and orange sand with coal and asphalt fragments (medium dense, wet) (no odor, no sheen)	
6						
Boring Completed 11/22/05 Total Depth of Boring = 6.0 ft.						
Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate. 2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions. 3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.						

TABLE 1
SOIL ANALYTICAL RESULTS
NORTH BOEING FIELD

	SLR-1 (1-2) KG70H 11/22/05	SLR-1 (3-4) KG70I 11/22/05	SLR-1 (5-6) KG70J 11/22/05	SLR-2 (1-2) KG70M 11/22/05	SLR-2 (3-4) KG70N 11/22/05	SLR-2 (5-6) KG70O 11/22/05	SLR-3 (1-2) KG70G 11/22/05	SLR-3 (3-4) KG70K 11/22/05	SLR-3 (5-6) KG70L 11/22/05	SLR-4 (1-2) KG70D 11/22/05	SLR-4 (3-4) KG70E 11/22/05	SLR-4 (5-6) KG70F 11/22/05	SLR-5 (1-2) KG70A 11/22/05	SLR-5 (3-4) KG70B 11/22/05	SLR-5 (4-5-5-0) KG70C 11/22/05
TCLP METALS															
EPA Method 8010B/7470A (mg/L)															
Arsenic	0.2 U							0.2 U							
Barium	0.00 U											0.2 U			
Cadmium	0.01 U							0.24				0.04			0.2 U
Chromium	0.02 U							0.01 U				0.01 U			1.01
Lead	0.1 U							0.02 U				0.02 U			0.01 U
Mercury	0.0001 U							0.1 U				0.1 U			0.1 U
Selenium	0.2 U							0.0001 U				0.0001 U			0.0001 U
Silver	0.02 U							0.2 U				0.2 U			0.2 U
								0.02 U				0.02 U			0.02 U
TOTAL PETROLEUM HYDROCARBONS															
NWTPH-Ox (mg/kg)															
Diesel Range Hydrocarbons						67									
Motor Oil						42						66			8.4 U
												360			23
POLYCHLORINATED BIPHENYLS (PCBs)															
EPA Method 8082 (µg/kg)															
Aroclor 1016	32 U	33 U	490 U	4,400 U	240 U	1,800 U	4,400 U	33 U	33 U	870 U	32 U	33 U	32 U	33 U	33 U
Aroclor 1242	32 U	39	490 U	4,400 U	240 U	1,800 U	4,400 U	33 U	40 U	870 U	32 U	33 U	32 U	33 U	33 U
Aroclor 1248	32 U	33 U	1,900	4,400 U	860	1,800 U	4,400 U	33 U	33 U	870 U	32 U	33 U	32 U	33 U	33 U
Aroclor 1254	32 U	33 U	1,900	200,000	240 U	1,800 U	4,400 U	33 U	33 U	870 U	32 U	33 U	32 U	33 U	33 U
Aroclor 1260	32 U	33 U	490 U	4,400 U	240 U	200,000	260,000	33 U	33 U	2,300	32 U	33 U	120	33 U	33 U
Aroclor 1221	32 U	33 U	490 U	4,400 U	240 U	1,800 U	4,400 U	33 U	33 U	870 U	32 U	33 U	32 U	33 U	33 U
Aroclor 1232	32 U	33 U	490 U	4,400 U	240 U	1,800 U	4,400 U	33 U	33 U	870 U	32 U	33 U	32 U	33 U	33 U
Total PCBs	1 U	39	3,800	200,000	650	200,000	260,000	ND	ND	2,300	ND	ND	120	ND	ND
VOLATILE ORGANIC COMPOUNDS (VOCs)															
EPA Method 8260B (µg/kg)															
Chloromethane								1.4 U							
Bromomethane								1.4 U							
Vinyl Chloride								1.4 U							
Chloroethane								1.4 U							
Methylene Chloride								2.7 U							
Acetone								79							
Carbon Disulfide								1.4 U							
1,1-Dichloroethene								1.4 U							
1,1-Dichloroethane								1.4 U							
trans-1,2-Dichloroethene								1.4 U							
cis-1,2-Dichloroethene								14							
Chloroform								85							
1,2-Dichloroethane								1.4 U							
2-Butanone								1.4 U							
1,1,1-Trichloroethane								6.8 U							
Carbon Tetrachloride								1.4 U							
Vinyl Acetate								1.4 U							
Bromodichloromethane								0.8 U							
1,2-Dichloropropane								1.4 U							
cis-1,3-Dichloropropene								1.4 U							
								1.4 U							

TABLE 1
SOIL ANALYTICAL RESULTS
NORTH BOEING FIELD

	SLR-1 (1-4)	SLR-1 (3-4)	SLR-1 (5-6)	SLR-2 (1-2)	SLR-2 (3-4)	SLR-2 (5-6)	SLR-3 (1-2)	SLR-3 (3-4)	SLR-3 (5-6)	SLR-4 (1-2)	SLR-4 (3-4)	SLR-4 (5-6)	SLR-5 (1-2)	SLR-5 (3-4)	SLR-5 (4-5-6)
	KG70H	KG70I	KG76J	KG70M	KG78N	KG70C	KG70J	KG70K	KG70L	KG70D	KG70E	KG70F	KG70A	KG70B	KG70C
	11/22/06	11/22/06	11/22/06	11/22/06	11/22/06	11/22/06	11/22/06	11/22/06	11/22/06	11/22/06	11/22/06	11/22/06	11/22/06	11/22/06	11/22/06
Trichloroethene															62
Dibromochloromethane															14 U
1,1,2-Trichloroethane															14 U
Benzene															14 U
trans-1,3-Dichloropropene															14 U
2-Chloroethyl vinyl ether															63 U
Bromoform															14 U
4-Methyl-2-Methylaniline (MIBK)															68 U
2-Pentanol															68 U
Tetrachloroethene															14 U
1,1,2,2-Tetrachloroethane															14 U
Toluene															14 U
Chlorobenzene															14 U
Ethylbenzene															14 U
Styrene															14 U
Trichlorofluoromethane															14 U
1,1,2-Trichloro-1,2,2,2-tetrafluoroethane															27 U
m,p-Xylene															14 U
o-Xylene															14 U
1,2-Dichlorobenzene															14 U
1,3-Dichlorobenzene															14 U
1,4-Dichlorobenzene															14 U
Acrolein															68 U
Methyl iodide															14 U
Bromomethane															27 U
Acetylene															68 U
1,1-Dichloropropene															14 U
Dibromomethane															14 U
1,1,1,2-Tetrachloroethane															14 U
1,2-Dibromo-3-chloropropane															68 U
1,2,3-Trichloropropane															27 U
trans-1,4-Dichloro-2-butene															68 U
1,3,5-Trimethylbenzene															14 U
1,2,4-Trimethylbenzene															14 U
Hexachlorobutadiene															68 U
Ethylene Dibromide															14 U
Bromochloromethane															14 U
2,2-Dichloropropane															14 U
1,3-Dichloropropane															14 U
Isopropylbenzene															14 U
n-Propylbenzene															14 U
Bromobenzene															14 U
2-Chlorotoluene															14 U
4-Chlorotoluene															14 U
tert-Butylbenzene															14 U
sec-Butylbenzene															14 U
4-Isopropyltoluene															14 U
n-Butylbenzene															14 U
1,2,4-Trichlorobenzene															68 U
Naphthalene															68 U
1,2,3-Trichlorobenzene															68 U

µg/kg = micrograms per kilogram (ppb)

mg/kg = milligrams per kilogram (ppm)

U = Indicates the analyte was not detected at the given reporting limit

J = Indicates the analyte was detected; the given concentration is an estimate

ME: Laboratory estimated value when analyte is detected and confirmed by analyst, but it has low spectral match parameters

ND = Not detected

Bold indicates detected analytes

TCLP = Toxicity Characteristic Leaching Procedure, prepared using EPA Method 1311